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ABSTRACT

This project examined the effectiveness of the three-lecture-per-week method of teaching general education biology as compared with six alternative approaches involving various reductions in weekly class attendance. In three of the experimental groups lectures were reduced in number and supplemented by readings, quiz sessions or study guides; in the other three attendance at lectures was not required, students were assigned readings, met in seminars, or were tutored by other students. Tape recordings of lectures and review sessions were available to all students. Students in all groups were administrated a pre-course examination, two midterm achievement examinations, and final tests of content, attitude to science and scientists, and attitude to the course. No significant differences were found on the attitude measures. On the final content test all experimental groups achieved significantly higher than the control section. It was noted that the students' expressed approval of an instructional method was not always supported by their use of the method when available. (EB)

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AN EXPLORATION OF ALTERNATIVE METHODS* FOR TEACHING LARGE SECTIONS OF GENERAL EDUCATION BIOLOGY

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The Commission on Undergraduate Education in Biological Science (CUEBS) has compiled guidelines for conducting general biology courses for non-majors. However, it failed to provide direction concerning the issue of instructional methodology.[1]

The effects of different teaching methods on student learning, attitude, understanding of the process of science, and evaluation of the course have not been conclusive.[2, 3] Although students have voiced dissatisfaction with large, impersonal classes for some time, the more recent student involvement in curriculum decisions has heightened the concern about large class enrollments on many campuses. Still, there has been little evidence that small classes will be considered seriously as alternatives for scheduling general courses in large sections.

The purpose of this study was to explore ways of reducing the size of the instructional unit within the confines of large section scheduling without sacrificing the quality of learning. Such reduction in class size demands either more

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contact hours by the instructor or a reduction of time spent with individual students. The latter alternative was investigated.

Procedure

A general education biology section having an enrollment of 400 students was divided randomly into six equal sections. A pre-test in achievement was administered which also served as an exemption examination. Hence the numbers of students assigned to the treatment groups were reduced in size unequally. The groups were assigned treatments as follows:

Lecture: Members of this group received only two lectures per week and the appropriate reading assignments.

Lecture-Quiz: Members of this group received two lectures and a quiz each week. The accumulated quiz scores were included in the determination of course grades.

Lecture-Study Guide: Members of this group received two lectures per week and were directed to answer study questions. The study question activity was not included in the determination of the course grade.

Student Instructor: Students in this treatment were assigned to small groups of six members. During one

session per week the graduate assistant trained student instructors, each of whom subsequently taught the assigned material to the other members of his group during the remaining sessions of the week.

Seminar: Students in this group met once per week with the instructor to discuss the readings assigned for the topics under consideration.

Readings: Members of this group attended class only to take examinations. They were instructed to use the extra time for reading supplementary materials.

The lecture, lecture-quiz, and lecture-study guide sections met together for large group lectures twice per week. For the third meeting, the teaching assistant administered the quiz and assisted those students who requested help with the study guide. The review sessions were scheduled for one evening per week by the teaching assistant.

The student-leaders were instructed one day per week by the teaching assistant using a content outline and reference list provided by the instructor. The student leaders met with the members of their respective groups as many times as they felt necessary during the remainder of the week. The seminar section met with the instructor once per week to review the readings assigned.

Each student was assigned a code number which he recorded on attendance sheets that were passed to those attending any meeting described. Students were encouraged to attend those sections which they felt were important for success in the course. Attendance data were recorded for all students, but were not used as a grading criterion.

The control section, taught by another instructor, met for three lectures per week. Students in all groups were administered a pre-course examination, two achievement examinations during the term, and the criterion instruments at the end of the ten week term. All students used the same textbook, followed the same course outline, and proceeded at approximately the same rate. All students were encouraged to use the tape-recordings of the lectures and to attend weekly review sessions.

Instrumentation

The intent of this investigation was to determine whether a reduction in student contact hours with the instructor or differences in mode of presentation would affect the performances of the students or their use of recordings of lectures and review sessions. Specifically, answers to the following questions were sought:

1. Will scores on achievement examinations show significant differences between the treatment groups?

2. Will scores on the Allison science attitude scale show significant differences between the treatment groups?
3. Will scores on the Course Attitude Questionnaire (CAQ) show significant differences between the treatment groups?
4. Will attendance at review sessions vary between the groups?
5. Will the proportion of students using tape-recorded lectures vary between the groups?

Results

The results of the investigation confirmed the suspicion that students would not be severely penalized by a reduced amount of class time. (see Table 1) The pretest mean scores did not differ between the groups significantly at the .05 level. However, in the first mid-term and final examinations, the mean score of each experimental group was significantly higher than that of the control group beyond the .01 level. Yet, the difference in variance between the experimental groups did not reach the .05 level. An analysis of covariance in which the pretest was held constant showed a significant difference in only the first mid-term examination. (see Table 2)

Students in the control section were informed that their grades would not be affected by their scores on the criterion

instruments. Hence, the examination scores for the control group in Table 1 were essentially artifacts.

The mean scores of neither the Allison's attitude scale (Table 1) nor the sub-scales of the Course Attitude Questionnaire differed significantly at the .05 level between the treatments. (see Table 3) The difference in mean scores between the students entering the second semester course who had undergone the experimental treatments and those who had had other first semester instructors was not significant at the .05 level. (see Table 4) Hence, none of the treatments was clearly better or worse than any other treatment as measured by achievement examinations, Allison's scale, or the Course Attitude Questionnaire.

A comparison of the attendance patterns demonstrated that students from each of the treatment groups sampled more than one instructional mode. (see Table 5) Also, it appeared that about half of the students who were not assigned to attend the lectures attended at least one lecture. However, students evidently saw little reason to attend the review sessions or use the audio lecture tapes as supplements to their instructional treatments. (see Table 6)

It may be seen from Table 7 that all of the instructional methods employed were viewed as useful by at least 30% of the experimental sample. However, only the lectures (99.4%), review

(70.6%), and student seminars (95.2%) were designated as useful by the majority of the students answering the questionnaire. It is interesting to note that the actual number of students who attended the reviews and student led seminars were only 17 (10%) and 40 (24%) respectively. Furthermore, the control group, none of whom attended student seminar sessions, submitted responses that paralleled those of the experimental sample.

Although only 29.5% believed the teacher-led seminars to be useful and 42.6% held similar esteem for the lecture-quiz approach, these modes received the most preference as the groups students would like to join if they were to undergo this type of experiment again.

In response to the last statement, the second semester course was organized to accommodate two lectures per week with optional teacher-led seminars and quizzes provided for the Saturday session of each week. Attendance figures shown in Table 8 suggest that these opportunities, although strongly supported by a few students, were not overwhelmingly popular alternatives to the straight lecture approach.

The second semester course also permitted examination of the degree to which the source of information influenced the use of review sessions and lecture tapes. (see Table 9) Content information for this course was drawn from both the textbook and

the lectures--each contributing information not available in the other. As it might be expected, proportionally more students used these instructional supplements during the second semester course in which the lectures became a more integral part of the instruction.

Discussion

This investigation was limited to two sections of a first semester general education biology course as presented at one institution. Furthermore, there was no monitoring of the two instructors other than their agreement to proceed over the same topical outline at approximately the same pace using the same text. No attempt was made to assess the relative capabilities of the instructors nor the sophistication or depth of the material they presented.

The differences in means for the first mid-term examination as shown in Table 2 indicated only temporary inequality. Apparently, the students in the low group, the instructor-led seminar, accommodated for any handicap that may have been produced by the mode of instruction. This result is consistent with the evidence cited by Mc Keachie that the motivation provided by grades stimulates students to perform acceptably regardless of instructional method, and, in turn, mutes any effect on performance that different methods might have demonstrated.[6]

The results from administering Allison's scale were not anticipated, however. Groups of fourth, fifth, and sixth graders recorded total score means ranging from 316.44 to 348.7, whereas the equivalent means for the college students in this investigation ranged from only 215.14 to 235.38. If the content of the course enhanced the students' attitudes toward science, scientists, and scientific careers, the change was not strong enough to equal the reported attitudes of the younger students.[7]

In addition, neither of the instructors fared well as compared to all of the other instructors who have used the Course Attitude Questionnaire. Mc Keachie suggested that certain students prefer courses in which they know exactly how they stand and what to expect at all times.[8] Such predictability was not evident during the course; evidently, student uneasiness in regard to the investigative nature of the course countered any potential Hawthorne effect.

Although there were definite differences in the degree to which students in the various treatments participated in each of the instructional modes, it was quite clear that there was substantial contamination between treatments. This observation suggests that students had instructional preferences or learning styles that did not conform to the treatment assignments.

Since a large number of students demonstrated by their

attendance and their preference statements that they favored the lecture as a technique, the notion that today's students desire relevant, high involvement courses may need qualification. A substantial number of this sample apparently were quite comfortable with the passive role imposed upon them by the large group lecture technique.

Responses indicating the value of student seminars suggested that there was considerable credibility attributed to the insights of other students regarding learning procedures. Since the formal student-led seminars were attended by relatively few students, these opinions must have reflected the prevalence of informal student seminars. Similarly, the usefulness of the review sessions was not determined by experience in this course. Rather, it was probably a value attached either to private review sessions or to the logic behind maintaining review sessions as an option. The inaccuracy of responses to questions about these two techniques implies that opinionnaires might be viewed cautiously as viable sources of research information.

Summary and Conclusions

From this investigation it was determined that a large section of general education biology students could be divided

into smaller groups, each receiving different amounts and kinds of instruction, with no apparent affect on their achievement, attitudes toward the course, or attitudes toward science.

It was evident that the lecture method was a popular form of instruction, students had preferences for different instructional methods, and the use of instructional techniques was proportional to their perceived relative value in producing acceptable grades.

Opinions regarding the usefulness of the various instructional techniques were of questionable value other than to identify factors that should receive additional investigation.

Empirical research on instructional methodology in higher education is wanting. Subsequent investigations should accommodate the interaction between instructor capabilities, student learning styles, and instructional methods.

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6. Mc Keachie, op. cit., 1125-1157.

7. Allison, op. cit., 57-59.

8. Mc Keachie, op. cit., 1125-1157.

TABLE 1

MEAN SCORES OF CRITERIA SHOWN BY TREATMENT GROUPS

Treatment No. of items =	Pre-test (85)	First Examination (45)	Second Examination (45)	Final Examination (85)	Allison's Scale (475)
Lecture	35.37	23.76	23.76	42.48	221.71
Seminar	33.62	21.78	22.96	41.37	223.05
Reading	34.46	23.61	23.28	43.13	218.14
Student Instructors	36.30	23.90	25.20	44.04	217.27
Lecture-Quiz	33.79	24.21	24.16	43.70	217.42
Lecture-Study Guide	35.29	24.43	23.25	42.46	216.14
Control	36.83	17.28*	18.37*	29.69*	235.38
	F = 0.458	3.48; p<.01	1.596	3.079; p<.01	0.579

*The examinations producing these mean scores were administered improperly. The following F values include only the first six treatments:

F =		0.494	1.045	0.162

TABLE 2

EXPERIMENTAL GROUPS' ACHIEVEMENT MEAN SCORES AND ADJUSTED MEAN SCORES
WITH PRE-TEST SCORES HELD CONSTANT

Treatment	Pre-Test	First Examination		Second Examination		Final Examination	
		Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Lecture	33.120	24.880	24.906	25.140	25.165	44.240	44.292
Seminar	32.408	22.143	22.377	23.490	23.717	42.061	42.532
Reading	33.560	23.540	23.478	23.320	23.260	42.940	42.816
Student Instructors	35.000	25.111	24.680	25.250	24.831	44.694	43.827
Lecture-Quiz	32.521	24.667	24.872	24.125	24.324	44.938	45.350
Lecture-Study Guide	33.691	24.762	24.667	23.857	23.765	43.167	42.975
Covariance, F =		2.772; p<.05			1.126		0.848

TABLE 3

SUBSCALE MEAN SCORES FOR THE COURSE ATTITUDE QUESTIONNAIRE

Treatment	General Course Attitude	Method	Content	Interest-Attention	Instruction	Other	Combined
Lecture	20.37	19.51*	19.80	17.40	22.09	24.86	124.03
Seminar	20.44	17.32	21.24*	19.00*	21.96	25.72	125.68
Reading	20.31	16.91	20.94*	16.81	21.19	25.41	121.56
Student Instructors	21.47*	17.73	20.93*	18.20*	21.33	26.20*	125.87
Lecture-Quiz	20.74	18.84	20.58*	16.90	21.58	25.03	123.68
Lecture-Study Guide	19.89	18.50	19.64	16.86	21.21	24.68	120.79
Control	19.94	18.07	19.83	17.03	21.29	24.89	121.04
F=	0.110	0.357	0.401	0.226	0.083	0.181	0.114

*These scores place the instructor at the tenth percentile in comparison with all other instructors who have used this instrument.

TABLE 4

PRE-SECOND SEMESTER COURSE ATTITUDE QUESTIONNAIRE SUBSCALE MEAN SCORES FOR STUDENTS FROM EXPERIMENTAL AND NON-EXPERIMENTAL FIRST SEMESTER SECTIONS

Treatment	General Course Attitude	Method	Content	Interest-Attention	Instruction	Other	Combined
Experimental Section	19.11	18.07	18.67	16.67	21.78	23.56	117.85
Non-Experimental First Semester Sections	21.04	19.69	20.30	19.14	21.44	25.41	127.02
F =	0.524	0.371	0.643	0.629	0.011	0.451	0.410

TABLE 5

AVERAGE ATTENDANCE BY TREATMENT GROUPS FOR INSTRUCTIONAL METHODS

Group	n	Lectures	Tapes	Reviews	Study Guide	Quizzes	Student Instructors	Seminars
Lecture	68	40.93 *	0.56	0.33	0.83	0.50	-	-
Seminar	62	9.33	0.22	0.56	0.67	0.17	-	24.50
Reading	60	8.73	0.56	0.33	1.33	0.50	-	-
St. Ins.	55	7.83	0.75	0.67	2.33	1.00	30.00	0.17
Quiz	65	41.53	1.00	0.33	2.33	49.50	0.17	-
Guide	55	38.33	0.38	-	34.50	-	-	-

*The underlined figure represents the assigned activity for that treatment group.

TABLE 6

USE OF LECTURES, LECTURE TAPES AND REVIEW SESSIONS BY TREATMENT GROUPS

Group	n	Students Using Lectures	Students Using Reviews	Review Use Frequency	Students Using Tapes	Tape Use Frequency
Lecture	68	68	3	3	5	8
Seminar	62	29	5	5	1	2
Reading	60	37	4	7	4	7
St. Ins.	55	32	5	6	6	11
Quiz	65	61	3	3	4	16
Guide	55	52	-	-	4	6

TABLE 7

PERCENTAGES OF STUDENT RESPONSES INDICATING THAT VALUE WAS DERIVED FROM SPECIFIED INSTRUCTIONAL TECHNIQUES

	Treatment Groups and Number Responding								
Technique	Lecture n = 35	Seminar n = 25	Reading n = 32	Student Instruct. n = 15	Lecture-Quiz n = 31	Lecture Study-Guide n = 28	Means (K=6)	Control n = 184	Means (K=7)
Lecture	100.0	100.0	100.0	93.3	100.0	100.0	99.4	96.8	96.0
Review	82.9	56.0	50.0	66.7	83.9	78.6	70.6	65.2	67.7
Tapes	48.6	64.0	53.1	46.7	41.9	39.3	49.5	47.8	48.4
Textbook	51.4	52.0	34.4	46.7	32.3	28.6	40.2	40.2	40.1
Student Sem.	85.7	88.0	100.0	100.0	100.0	100.0	95.2	82.6	91.7
Instruct. Sem.	40.0	32.0	21.9	53.3	9.7	32.1	29.5	28.3	28.3
Quizzes	42.9	72.0	25.0	40.0	35.5	46.4	42.6	35.3	38.6
Study Guide	40.0	40.0	18.7	40.0	67.7	35.7	40.5	33.7	37.1
Readings	45.7	48.0	28.1	53.3	38.7	78.6	47.7	49.5	48.4

TABLE 8

SECOND SEMESTER ATTENDANCE FOR SATURDAY QUIZ AND SEMINAR SECTIONS[a]

Session Number	Quiz Attendance	Seminar Attendance
1	40	78
2	10	42
3	9	15
4	7	14
5	7	4
6	8	7
7	9	11

[a] N = 229

TABLE 9

COMPARISON OF USE OF TAPES AND REVIEW SESSIONS BY STUDENTS IN FIRST SEMESTER AND SECOND SEMESTER COURSES

Course	n	Students/ Term Using Tapes	Tapes Used per Lecture	Students/ Term Using Review	Attendance per Session
First Semester	365	24	2.63	20	2.67
Second Semester	229	36	4.60	50	23.25

The Pennsylvania State University Course Attitude Questionnaire

A B C D

USE A #2 PENCIL FOR MARKING. DO NOT USE BALL POINT PEN OR RED PENCIL. ERASE ALL UNINTENDED MARKS.

SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree

1	I learn more when other teaching methods are used.	SA A D SD	26	Some things were not explained very well.	SA A D SD
2	It was a waste of time.	SA A D SD	27	The way in which this course was taught results in better student learning.	SA A D SD
3	Overall, the course was good.	SA A D SD	28	The course material was too difficult.	SA A D SD
4	The textbook was very good.	SA A D SD	29	One of my poorest courses.	SA A D SD
5	The instructor seemed to be interested in students as persons.	SA A D SD	30	Material in the course was easy to follow.	SA A D SD
6	More courses should be taught this way.	SA A D SD	31	The instructor seemed to consider teaching as a chore or routine activity.	SA A D SD
7	The course held my interest.	SA A D SD	32	More outside reading is necessary.	SA A D SD
8	I would have preferred another method of teaching in this course.	SA A D SD	33	Course material was poorly organized.	SA A D SD
9	It was easy to remain attentive.	SA A D SD	34	Course was not very helpful.	SA A D SD
10	The instructor did not synthesize, integrate or summarize effectively.	SA A D SD	35	It was quite interesting.	SA A D SD
11	Not much was gained by taking this course.	SA A D SD	36	I think that the course was taught quite well.	SA A D SD
12	The instructor encouraged the development of new viewpoints and appreciations.	SA A D SD	37	I would prefer a different method of instruction.	SA A D SD
13	The course material seemed worthwhile.	SA A D SD	38	The pace of the course was too slow.	SA A D SD
14	It was difficult to remain attentive.	SA A D SD	39	At times I was confused.	SA A D SD
15	Instructor did not review tests promptly and in such a way that students could understand their weaknesses.	SA A D SD	40	Excellent course content.	SA A D SD
16	Homework assignments were helpful in understanding the course.	SA A D SD	41	The examinations were too difficult.	SA A D SD
17	There was not enough student participation for this type of course.	SA A D SD	42	Generally, the course was well organized.	SA A D SD
18	The instructor had a thorough knowledge of his subject matter.	SA A D SD	43	Ideas and concepts were developed too rapidly.	SA A D SD
19	The content of the course was good.	SA A D SD	44	The content of the course was too elementary.	SA A D SD
20	The course increased my general knowledge.	SA A D SD	45	Some days I was not very interested in this course.	SA A D SD
21	The types of test questions used were good.	SA A D SD	46	It was quite boring.	SA A D SD
22	Held my attention throughout the course.	SA A D SD	47	The instructor exhibited professional dignity and bearing in the classroom.	SA A D SD
23	The demands of the students were not considered by the instructor.	SA A D SD	48	Another method of instruction should have been employed.	SA A D SD
24	Uninteresting course.	SA A D SD	49	The course was quite useful.	SA A D SD
25	It was a very worthwhile course.	SA A D SD	50	I would take another course that was taught this way.	SA A D SD

A 1 2 3 4 5 B 1 2 3 4 5 C 1 2 3 4 5 D 1 2 3 4 5 E 1 2 3 4 5 F 1 2 3 4 5

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